**ABSTRACT**

South Africa is one of the major users of pesticides in Sub-Saharan Africa. With skin being the major route of exposure to pesticides, it is important for health care workers to be aware of the spectrum of dermatoses that can be caused by these agents. Pesticides may act as irritants and/or allergens to the skin causing dermatoses including contact dermatitis, erythema multiforme, chloracne and ashy dermatosis. An increased risk of skin cancer has been noted as well among professional pesticide sprayers. While farmers should be made aware of viable alternatives and low-cost forms of pest control for agricultural production, it is vital that clinicians keep occupational exposures in mind when a patient presents with dermatoses.

After the 1994 democratic elections, South African agricultural policies were adjusted to empower previously disadvantaged farmers which saw an increase in pest management efforts towards their management.

Pesticides are agents used to control, e.g. herbicides, insecticides, and acaricides to mitigate any pest ranging from insects, animals and weeds to micro-organisms. These are classified according to their functional class (i.e. the organisms that they are designed to control, e.g. herbicides, insecticides, fungicides, etc.) or by their chemical class (e.g. organophosphates or triazines etc.).

Skin is the major route of exposure to pesticides. The exposure varies depending on crop, climate, location and regulatory requirements. Slodownik et al. argue that almost all chemicals can cause irritant contact dermatitis, but pesticides can cause a spectrum of pesticide-related dermatoses (Table I).

### OCCUPATIONAL EXPOSURES

Given their importance in agriculture, vector control, and structural (buildings) protection, pesticides will continue to be used and will therefore be present in the human environment. In the agriculture sector, mixing and application comprise the most hazardous phase of use of pesticides since the worker is exposed to the concentrate for prolonged periods of time. Dermal contamination occurs during application as well as during mixing and handling of concentrated formulations.

Other hazards include exposures with the workers entering a sprayed area too soon after spraying, cleaning the spraying and mixing equipment (including personal protective equipment if used), disposing of empty containers, sowing pesticide-preserved seeds, weeding and pruning, and harvesting previously sprayed crops. Women and children in South Africa comprise a large proportion of the agricultural labour force, which makes them particularly vulnerable.

### PATHOGENESIS

Pesticides may act as irritants and/or allergens to the skin. Some pesticide components are capable of increasing the skin sensitivity to light which results in phototoxic reactions, or they may undergo a photo-activated chemical reaction with the generation of photoallergens (photallergens). It is not only the pesticides per se that cause skin reactions. Degradation products of the active components, excipients or additives could be involved and need consideration. Genetic variation plays a role in influencing human susceptibility to pesticides. For example, metabolism of organophosphate pesticides is influenced by a number of genes including paraoxonase and the cytochrome P450s.

Irritants share the same pathophysiological changes of skin-barrier disruption, epidermal cellular damage and release of pro-inflammatory mediators. Keratinocytes play a major role in the production of immunological response to irritants. They release cytokines upon the disruption of the skin barrier, upregulate their major histocompatibility class II antigens and upregulate cell adhesion molecules.

The pro-inflammatory cytokines interleukin-1α, interleukin-1β and tumour necrosis factor-alpha (TNF-α) have been found to be upregulated in the irritant reaction.
whereas the mechanism of chemical-induced allergy is dependent on \( \text{Th1} \) and \( \text{Th2} \) cytokines.

**SPECTRUM OF DERMATOSES DUE TO PESTICIDES**

**Contact dermatitis** is a commonly occurring skin disease related to pesticides, both allergic and irritant. Generally, hands (palm and back), feet, back and legs (front) get more affected than forearms, legs (back) and thighs (front), which are usually covered with clothes.\(^6\)

Other pesticide-related conditions that have been reported are shown in Table II.

**Erythema multiforme**-like eruptions are regarded as a form of allergic contact dermatitis. A case, reported by Mendaza et al.\(^{17}\) documented eruptions that occurred after an irritant contact dermatitis due to a glyphosate pesticide. Both organophosphorus insecticide methyl parathion and dimethoate have been reported to cause erythema multiforme a few hours after contact.\(^{18}\)

**Ashy dermatoses** occur predominantly in dark-skinned individuals and is usually characterised by single or multiple ashen maculae of variable size and shape. Penagos et al.\(^7\) reported ashy dermatosis caused by chlorothalonil in 39 banana farm workers in Panama. Bleiberg et al.\(^{19}\) described pesticide-related porphyria cutanea tarda in 3 workers caused by herbicides 2, 4-dichlorophenol and 2, 4, 5-trichlorophenol.

**Chloracne** is caused by chlorinated polycyclic aromatic hydrocarbons, among them pesticides or their contaminants. The assessment of acnegenic potential of a given preparation is very challenging as the final product may be contaminated with raw materials, intermediate compounds and decomposition products which are not specified on the label.\(^6\)

**Cancer** risk has increased in professional pesticide sprayers. The International Agency for Research on Cancer has reported an increase in the risk of developing skin and lip cancer among this group.\(^{20}\) Arsenic pesticides have strong carcinogenic properties and although no longer in use, every farmer presenting with skin cancer should be asked about exposure to arsenic pesticides 40-50 years ago. Signs of long-term arsenic exposure are palmoplantar keratosis (excessive thickening of hand palms and foot soles) and chronic skin inflammation of distal body parts (acrodermatitis atrophicans). Later carcinoma \textit{in situ} (Bowen's), basal cell carcinomas and squamous cell carcinomas may appear.\(^7\)

**APPRAOCH**

**Diagnosis**

Diagnosis and screening of pesticide-related contact skin diseases is very difficult because of constant changes in the preparations used. A comprehensive history, including occupational exposures, is essential. Attention should be given to the intensity, frequency and duration of exposures and the exposed skin surface area. The clinician must also determine any relationship between fluctuations in the dermatitis and other factors, for example, time off work and the performance of certain hobbies.

**Patch testing**

While it may be challenging distinguishing between irritant and allergic contact dermatitis, it is important to make the distinction as their management is different. Patch testing is necessary to differentiate between allergic and irritant contact dermatitis; however it is not commonly used for pesticides\(^7\) since commercial pesticide test trays are limited by the fact that pesticides in use are so many, vary by geographic regions and crops and they also change over time. The disadvantage of patch testing is that it may cause false-positives because of irritation of the skin – “the excited skin syndrome”.\(^8\)

**Monitoring**

In order to assess the efficacy of control procedures and help reduce exposure, monitoring of pesticide exposure is vital. Monitoring can be done either by blood or urine analysis. Blood monitoring can be done through plasma or red blood cell (RBC) cholinesterase activity.
Whereas plasma cholinesterase reflects current absorption, RBC cholinesterase reflects the concurrent effect on the neurological system. Because of the large inter-individual variability in cholinesterase activity it is advisable to establish baseline cholinesterase values for workers. Using urine analysis for monitoring may be less invasive andlogistically simpler; however a 24-hour sample is requested.21

The clinician should bear in mind that many products in daily use (rubber, medications, housekeeping means) contain pesticides or chemically related substances capable of provoking relapses of the disease. Even if a pesticide is no longer on the market, sensitisation to it may last for many years and eventually re-appear due to cross-reaction with a new pesticide structurally related to the primary sensitiser. Irritant dermatitis can be prevented by reduction of exposure through the use of personal protective equipment and administrative controls while allergic contact dermatitis can be avoided by removing the employee from the environment with the causative agent.22

CONCLUSION
Skin diseases make up just a third of pathologies caused by pesticides.10 A continual increase in the use of pesticides will see an increase in pesticide-related diseases; this emphasises the need for insight and awareness among both clinicians and users. A challenge in developing countries is the lack of knowledge about the adverse health effects of pesticides, lack of washing rooms at the fields, skills, technical advice and health and safety support. The importance of maintenance of equipment, the correct techniques when using manual spraying, the type of clothes worn (Fig. 1), particularly the use of gloves (considering frequent hand contact with pesticides) and avoidance of direct contact with pesticides are vital. Also emerging farmers should be made aware of viable alternatives and low-cost forms of pest control for agricultural production.1

Declaration of conflict of interest
The author declares no conflict of interest.

REFERENCES